PROF. GUIDO CORA has lately printed the address he delivered in November 1883 at the opening of the annual course of geographical studies in the University of Turin. This address, dealing with the surface of the earth as the proper subject of geography, has a special interest for the English public, who are just now occupied with the question of geographical reform. The author accordingly appeals more particularly to those English men of science "who seem still to entertain grave doubts whether geography really possesses a scientific and individual character, and whether it is entitled to be taught even in Universities." Amongst the subjects discussed are, the relations of geography to the other sciences, geography an individual science, separation of geology from geography, division of geography in reference to its subject-matter and methods of investigation, mathematical and physical geography, necessity of teaching geography according to the most exact scientific and didactic methods.

AT the last meeting of the Geographicnl Society of Paris, a letter was read from Major Serpa Pinto, dated Zanzibar, December 10, describing his recent explorations in Eastern Equatorial Africa. He started from Mozambique, and followed the coast, carefully examining the country as he proceeded, until he reached Ibo. Here he organised a large expedition with 200 guards and 700 bearers, carrying provisions and wares, and started for Lake Nyassa, which he reached without difficulty. On the journey he undertook a triangulation survey with levelling. Major Pinto was forced to return to the coast by himself from Nyassa, on account of ill-health; but M. Cardozo, his second in command, continued the journey, and at the time of writing should have been between Nyassa and Bangweolo. Capt. Monteil, of the French Marines, read a paper on the French establishments in Senegal.

A LENGTHY report from M. Thouar to the President of the Argentine Republic, on the Pilcomayo River, has been published. The object of his last exploration was to seek the branch of the river which was most navigable. Leaving Fort Fotheringham on October 25, he reached, on November 12, the rapids, the point which, from the other side, he reached with the Bolivian Expedition in 1883. His conclusion is that it is possible to go at any season of the year from the mouth at Lamboré to the mission of San Francisco de Solano in Bolivia, at the very foot of the Andes, at a short distance from the principal commercial centres of Southern Bolivia. The difficulties caused by accumulations of trees, and the consequent formation of shallows can, in his judgment, be overcome. The report then goes on to describe the incidents of the journey, and the hostility of the Toba Indians, which more than once threatened the existence of the Expedition. M. Thouar left in the beginning of February for Bolivia, crossing the Chaco between the 18th and 19th parallels, still intent on his exploration of the Pilcomayo from the Bolivian side.

THE current *Zeitschrift* (Bd. xxi. Heft 1) of the Berlin Geographical Society has for its first contribution a paper of great interest on the discovery and conquest of Chili, the portion published in the present number dealing with the period between the discovery of the Straits of Magellan and the death of Pedro de Valdivia (1520–54). The writer, Herr Polakowsky, tells the story of the stirring events of which Chili was the theatre at this time with much fire and vigour. The second paper is also devoted to South America. It is an account (accompanied by a map) by Capt. Rohde, of the expedition of Gen. Victorica to the Grand Chaco. The writer first gives some general information about the Chaco, its size, natural divisions, productions, flora and fauna, so far as they are known; then he refers to earlier expeditions, and this brings him to the plan of the campaign under review, and to the events attending the march of the column specially under the command of General Victorica, and of the other columns acting in conjunction with it. As part of this comes the work on the Pilcomayo and Bernejo of Lieut. Feilberg, of which much has already been heard in Europe. In conclusion a list is given of the trees of the Chaco, their native and botanical names, with a few words of description in each case. A shorter paper (the last in the number) is a report on the same expedition by the head of the Topographical Department of the Argentine army. From a geographical and geological point of view this is the most valuable part of the accounts of the campaign. It describes the geology, climate, zoology, mineralogy, &c., of the Chaco.

THE *Verhandlungen* (Band xiii., No. 2) of the same Society contains a paper, by Dr. Zintgraff, entitled "Impressions of the Lower Congo." The writer was a volunteer with Dr. Chavanne, who was despatched to map the lower part of the river, and does not appear to be able to add much that is new to our knowledge of this region. Dr. Ehrenreich writes on the land and people in the Rio Doce in Brazil. This is a paper of much interest, as it sketches the life and habits of a comparatively little-known people, from long and careful observation. Herr Paul Reichard has a long report on his journeys in Eastern Africa and the regions around the source of the Congo. These journeys, of which much has been heard from time to time, extended over about five years, and the present is a popular account of some of their leading features.

THE *Mittheilungen* of the Vienna Geographical Society (Band xxix., No. 2) contains an account by Dr. Breitenhohner, the Director of the Meteorological Station at Sonnblick, near Salzburg, which is the loftiest in the world, being more than twice as high as the Ben Nevis Station. Herr Steinhauser continues and concludes his review of the mathematical geography of the last five years, which takes the form of a series of notes on various books. Dr. Diener continues his contribution to the geography of Central Syria, while further letters from the Congo, from Dr. Lenz, are published.

UNIVERSAL OR WORLD TIME[1]

CONSIDERING the natural conservatism of mankind in the matter of time-reckoning it may seem rather a bold thing to propose such a radical change as is involved in the title of my discourse. But in the course of the hour allotted to me this evening, I hope to bring forward some arguments which may serve to show that the proposal is not by any means so revolutionary as might be imagined at the first blush.

A great change in the habits of the civilised world has taken place since the old days when the most rapid means of conveyance from place to place was the stage-coach, and minutes were of little importance. Each town or village then naturally kept its own time, which was regulated by the position of the sun in the sky. Sufficient accuracy for the ordinary purposes of village life could be obtained by means of the rather rude sun-dials which are still to be seen on country churches, and which served to keep the village clock in tolerable agreement with the sun. So long as the members of a community can be considered as stationary, the sun would naturally regulate, though in a rather imperfect way, the hours of labour and of sleep and the times for meals, which constitute the most important epochs in village life. But the sun does not really hold a very despotic sway over ordinary life, and his own movements are characterised by sundry irregularities to which a well-ordered clock refuses to conform.

Without entering into detailed explanation of the so-called "Equation of Time," it will be sufficient here to state that, through the varying velocity of the earth in her orbit, and the inclination of that orbit to the ecliptic, the time of apparent noon as indicated by the sun is at certain times of the year fast and at other times slow, as compared with 12 o'clock or noon by the clock. [The clock is supposed to be an ideally perfect clock going uniformly throughout the year, the uniformity of its rate being tested by reference to the fixed stars.] In other words, the solar day, or the interval from one noon to the next by the sun, is at certain seasons of the year shorter than the average, and at others longer, and thus it comes about that by the accumulation of this error of going, the sun is at the beginning of November more than 16 minutes fast, and by the middle of February 14½ minutes slow, having lost 31 minutes, or more than half-an-hour, in the interval. In passing it may be mentioned as a result of this that the afternoons in November are about half-an-hour shorter than the mornings, whilst in February the mornings are half-an-hour shorter than the afternoons. In view of the importance attached by some astronomers to the use of exact local time in civil life, it would be interesting to know how many villagers have remarked this circumstance.

It is essential to bear these facts in mind when we have to consider the extent to which local time regulates the affairs of life, and the degree of sensitiveness of a community to a deviation of half-an-hour or more in the standard reckoning of time. My own

[1] Lecture by W. H. M. Christie, F.R.S., Astronomer-Royal, at the Royal Institution, March 19, 1886.

experience is that in districts which are not within the influence of railways the clocks of neighbouring villages commonly differ by half-an-hour or more. The degree of exactitude in the measurement of local time in such cases may be inferred from the circumstance that a minute hand is usually considered unnecessary. I have also found that in rural districts on the Continent arbitrary alterations of half-an-hour fast or slow are accepted not only without protest but with absolute indifference.

Even in this country where more importance is attached to accurate time, I have found it a common practice in outlying parts of Wales (where Greenwich time is about 20 minutes *fast* by local time) to keep the clock half-an-hour fast by railway (*i.e.* Greenwich) time, or about 50 minutes fast by local time. And the farmers appeared to find no difficulty in adapting their hours of labour and times of meals to a clock which at certain times of the year differed more than an hour from the sun.

There is a further irregularity about the sun's movements which makes him a very unsafe guide in any but tropical countries. He is given to indulging in a much larger amount of sleep in winter than is desirable for human beings who have to work for their living and cannot hibernate as some of the lower animals do. To make up for this he rises at an inconveniently early hour in summer and does not retire to rest till very late at night. Thus it would seem that a clock of steady habits would be better suited to the genius of mankind.

Persons whose employment requires daylight must necessarily modify their hours of labour according to the season of the year, whilst those who can work by artificial light are practically independent of the vagaries of the sun. Those who work in collieries, factories, or mines, would doubtless be unconscious of a difference of half-an-hour or more between the clock and the sun, whilst agriculturists would practically be unaffected by it, as they cannot have fixed hours of labour in any case.

Having thus considered the regulating influence of the sun on ordinary life within the limits of a small community, we must now take account of the effect of business intercourse between different communities separated by distances which may range from a few miles to half the circumference of our globe. So long as the means of communication were slow, the motion of the traveller was insignificant compared with that due to the rotation of the earth, which gives us our measure of time. But it is otherwise now, as I will proceed to explain.

Owing to the rotation of the earth about its axis, the room in which we now are is moving eastward at the rate of about 600 miles an hour. If we were in an express train going eastward at a speed of sixty miles an hour (relatively to places on the earth's surface), the velocity of the traveller due to the combined motions would be 660 miles an hour, whilst if the train were going westward it would be only 540 miles. In other words, if local time be kept at the stations, the apparent time occupied in travelling sixty miles eastward would be 54 minutes, whilst in going sixty miles westward it would be 66 minutes. Thus the journey from Paris to Berlin would apparently take an hour and a half longer than the return journey, supposing the speed of the train to be the same in both cases.

In Germany, under the influence of certain astronomers, the system of local time has been developed to the extent of placing posts along the railways to mark out each minute of difference of time from Berlin. Thus there is an alteration of one minute in time reckoning for every ten miles eastward or westward, and even with the low rate of speed of German trains, this can hardly be an unimportant quantity for the engine-drivers and guards, who have to alter their watches one minute for every ten miles they have travelled east or west. This would seem to be the *reductio ad absurdum* of local time.

In this country the difficulty as to the time reckoning to be used on railways was readily overcome by the adoption of Greenwich time throughout Great Britain. The railways carried London (*i.e.* Greenwich) time all over the country, and thus local time was gradually displaced. The public soon found that it was important to have correct railway time, and that even in the west of England, where local time is about 20 minutes behind Greenwich time, the discordance between the sun and the railway clock was of no practical consequence. It is true that for some years both the local and the railway times were shown on village clocks by means of two minute-hands, but the complication of a dual system of reckoning time naturally produced inconvenience, and local time was gradually dropped. Similarly in France, Austria, Hungary, Italy, Sweden, &c., uniform time has been carried by the railways throughout each country. It is noteworthy that in Sweden the time of the meridian one hour east of Greenwich has been adopted as the standard, and that local time at the extreme east of Sweden differs from the standard by about 36½ minutes.

But in countries of great extent in longitude such as the United States and Russia, the time-question was not so easily settled. It was in the United States and Canada that the complication of the numerous time standards then in use on the various railways forced attention to the matter. To Mr. Sandford Fleming, the constructor of the Inter-Colonial Railway of Canada and engineer-in-chief of the Pacific Railway, belongs the credit of having originated the idea of a universal time to be used all over the world. In 1879 Mr. Fleming set forth his views on time-reckoning in a remarkable paper read before the Canadian Institute. In this he proposed the adoption of a universal day, commencing at Greenwich mean noon or at midnight of a place on the anti-meridian of Greenwich, *i.e.*, in longitude 180° from Greenwich. The universal day thus proposed would coincide with the Greenwich astronomical day, instead of with the Greenwich civil day which is adopted for general use in this country.

The American Metrological Society in the following year issued a report recommending that, as a provisional measure, the railways in the United States and Canada should use only five standard times, 4, 5, 6, 7, and 8 hours respectively later than Greenwich, a suggestion originally made in 1875 by Prof. Benjamin Peirce. This was proposed as an improvement on the then existing state of affairs, when no fewer than seventy-five different local times were in use on the railroads, many of them not differing more than 1 or 2 minutes. But the committee regarded this merely as a step towards unification, and they urged that eventually one common standard should be used as railroad and telegraph time throughout the North American continent, this national standard being the time of the meridian 6 hours west of Greenwich, so that North American time would be exactly 6 hours later than Greenwich time.

Thanks to the exertions of Mr. W. F. Allen, Secretary of the General Railway Time Convention, the first great practical step towards the unification of time was taken by the managers of the American railways on November 18, 1883, when the five time standards above mentioned were adopted. Mr. Allen stated in October 1884 that these times were already used on 97½ per cent. of all the miles of railway lines, and that nearly 85 per cent. of the total number of towns in the United States of over 10,000 inhabitants had adopted them.

I wish to call particular attention to the breadth of view thus evidenced by the managers of the American railways. By adopting a national meridian as the basis of their time-system, they might have rendered impracticable the idea of a universal time to be used by Europe as well as America. But they rose above national jealousies, and decided to have their time-reckoning based on the meridian which was likely to suit the convenience of the greatest number, thus doing their utmost to promote uniformity of time throughout the world by setting an example of the sacrifice of human susceptibilities to general expediency.

Meanwhile Mr. Sandford Fleming's proposal had been discussed at the Geographical Congress at Venice in 1881, and at a meeting of the Geodetic Association at Rome in 1883. Following on this a special Conference was held at Washington in October 1884, to fix on a meridian proper to be employed as a common zero of longitude and standard of time-reckoning throughout the globe. As the result of the deliberations it was decided to recommend the adoption of the meridian of Greenwich as the zero for longitude, and the Greenwich civil day (commencing at Greenwich midnight and reckoned from 0 to 24 hours) as the standard for time reckoning. In making this selection the delegates were influenced by the consideration that the meridian of Greenwich was already used by an overwhelming majority of sailors of all nations, being adopted for purposes of navigation by the United States, Germany, Austria, Italy, &c. Further, the United States had recently adopted Greenwich as the basis of their time-reckoning, and this circumstance in itself indicated that this was the only meridian on which the Eastern and Western Hemispheres were likely to agree.

The difficulties in the way of an agreement between the two hemispheres may be appreciated by the remarks of the Superintendent of the American Ephemeris on Mr. Sandford Fleming's scheme for universal time (which was subsequently adopted in its essentials at the Washington Conference) :—"A capital plan

for use during the millenium. Too perfect for the present state of humanity. See no more reason for considering Europe in the matter than for considering the inhabitants of the planet Mars. No; we don't care for other nations, can't help them, and they can't help us." [1]

As a means of introducing universal time, it has been proposed by Mr. Sandford Fleming, Mr. W. F. Allen, and others, that standard times based on meridians differing by an exact number of hours from Greenwich should be used all over the world. In some cases it may be that a meridian differing by an exact number of half-hours from Greenwich would be more suitable for a country like Ireland, Switzerland, Greece, or New Zealand, through the middle of which such a meridian would pass, whilst one of the hourly meridians would lie altogether outside of it.

The scheme of hourly meridians, though valuable as a step towards uniform time, can only be considered a provisional arrangement, and though it may work well in countries like England, France, Italy, Austria, Hungary, Sweden, &c., which do not extend over more than one hour of longitude, in the case of such an extensive territory as the United States difficulties arise in the transition from one hour-section to the next which are only less annoying than those formerly experienced, because the number of transitions has been reduced from seventy-five to five, and the change of time has been made so large that there is less risk of its being overlooked. The natural inference from this is that one time-reckoning should be used throughout the whole country, and thus we are led to look forward to the adoption in the near future of a national standard time, 6 hours slow by Greenwich, for railways and telegraphs throughout North America.

We may then naturally expect that by the same process which we have witnessed in England, France, Italy, Sweden, and other countries, railway time will eventually regulate all the affairs of ordinary life. There may of course be legal difficulties arising from the change of time-reckoning, and probably in the first instance local time would be held to be the legal time unless otherwise specified.

It seems certain that when a single standard of time has been adopted by the railways throughout such a large tract of country as North America, where we have a difference of local times exceeding five hours, the transition to universal time will be but a small step.

But it is when we come to consider the influence of telegraphs on business life, an influence which is constantly exercised, and which is year by year increasing, that the necessity for a universal or world time becomes even more apparent. As far as railways are concerned, each country has its own system, which is to a certain extent complete in itself, though even in the case of railways the rapidly increasing inter-communication between different countries makes the transition in time-reckoning on crossing the frontier more and more inconvenient. Telegraphs, however, take no account of the time kept in the countries through which they pass, and the question, as far as they are concerned, resolves itself into the selection of that system of time-reckoning which will give least trouble to those who use them.

For the time which is thus proposed for eventual adoption throughout the world, various names have been suggested. But whether we call it Universal, Cosmic, Terrestrial, or what seems to me best of all, World Time, I think we may look forward to its adoption for many purposes of life in the near future.

The question, however, arises as to the starting-point for the universal or world day. Assuming that, as decided by the great majority of the delegates at Washington, it is to be based on the meridian of Greenwich, it has still to be settled whether the world day is to begin at midnight or noon of that meridian. The astronomers at Rome decided by a majority of twenty-two to eight in favour of the day commencing at Greenwich noon, that is, of making the day throughout Europe begin about mid-day. However natural it might be for a body of astronomers to propose that their own peculiar and rather inconvenient time-reckoning should be imposed on the general public, it seems safe to predict that a World Day which *commenced* in the *middle* of their busiest hours would not be accepted by business men. In fact, the idea on which this proposal was founded was that universal time would be used solely for the internal administration of railways and telegraphs, and that accurate local time must be rigidly adhered to for all other purposes. It was conceded, however, that persons who travelled frequently might with advantage use universal time during railway journeys. This attempt to separate the travelling from the stationary public seems to be one that is not likely to meet with success even temporarily, and it is clear that in the future the latter class may be expected to be completely absorbed in the former. Another argument that influenced the meeting at Rome was the supposed use of the astronomical day by sailors. Now it appears that sailors never did use the astronomical day, which begins at the noon *following* the civil midnight of that date, but the nautical day, which begins at the noon *preceding*, *i.e.* twenty-four hours before the astronomical day of the same date, ending when the latter begins. And the nautical day itself has long been given up by English and American sailors, who now use a sort of mongrel time-reckoning, employing civil time in the log-book and for ordinary purposes, whilst, in working up the observations on which the safe navigation of the ship depends, they are obliged to change civil into astronomical reckoning, altering the date where necessary, and interpreting their a.m. and p.m. by the light of nature. It says something for the common-sense of our sailors that they are able to carry out every day without mistake this operation, which is considered so troublesome by some astronomers.

In this connection I may mention that the Board of Visitors of Greenwich Observatory have almost unanimously recommended that, in accordance with the resolution of the Washington Conference, the day in the English Nautical Almanac should be arranged from the year 1891 (the earliest practicable date) to begin at Greenwich midnight (so as to agree with civil reckoning, and remove this source of confusion for sailors), and that a committee appointed by them have drawn up the details of the changes necessary to give effect to this resolution without causing inconvenience to the mercantile marine.

The advantage of making the world day coincide with the Greenwich civil day is that the change of date at the commencement of a new day falls in the hours of the night throughout Europe, Africa, and Asia, and that it does not occur in the ordinary office hours (10 a.m. to 4 p.m.) in any important country except New Zealand. In the United States and Canada the change of date would occur after four in the evening, and in Australia before ten in the morning. This arrangement would thus reduce the inconvenience to a minimum, as the part of the world in which the change of date would occur about the middle of the local day is almost entirely water, whilst on the opposite side we have the most populous continents.

The question for the future seems to be whether it will be found more troublesome to change the hours for labour, sleep, and meals once for all in any particular place, or to be continually changing them in communications from place to place, whether by railway, telegraph, or telephone. When universal or world time is used for railways and telegraphs, it seems not unlikely that the public may find it more convenient to adopt it for all purposes. A business man who daily travels by rail, and constantly receives telegrams from all parts of the world, dated in universal time, would probably find it easier to learn once for all that local noon is represented by 17h. U.T. and midnight by 5h. (as would be the case in the Eastern States of North America), and that his office hours are 15h. to 21h. U.T., than to be continually translating the universal time used for his telegrams into local time.

If this change were to come about, the terms noon and midnight would still preserve their present meaning with reference to local time, and the position of the sun in the sky, but they would cease to be inseparably associated with 12 o'clock.

[1] *Proceedings* of the Canadian Institute, Toronto, No. 143, July 1885.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 2, 1886.—On the galvanic conductivity of some easily fusible metallic alloys, by C. L. Weber.—On the electric conductivity of double-salts, by E. Klein.—On the galvanic polarisation of lead, by F. Streintz and E. Aulinger.—Experiment to determine the maximum of galvanic polarisation, by A. Föppl.—On the electro-magnetic rotation of the polarisation of light in iron, by A. Kundt.—Electro-magnetic rotation of natural light, by L. Sohncke.—On determination of the capillary constants of liquids, by S. Quincke.—On the relative permeability of different diaphragms and their availability as dialytic partitions, by A. Zott.—On the influence of temperature and concentration on the fluidity of liquid mixtures,